Amendments to the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims

Claims 1-16 (Canceled)

17. (Withdrawn) A magnetometer comprising:

a resonant sensor for sensing a magnetic field, said sensor generating an output signal having a signal characteristic that varies in response to the sensed magnetic field and in response to an applied bias;

a biasing circuit for adjustably biasing said sensor at two or more bias levels; and

a processor coupled to receive the output signal from said sensor, said processor determines the magnetic field component sensed by said sensor,

wherein the peak to peak excursion of the magnetic field level in said resonant sensor during a resonant cycle is a fraction of the field level excursion range due to the adjustment of the bias circuit over its total range of adjustment.

18. (Withdrawn) The magnetometer of claim 17, wherein said biasing circuit dynamically biases said sensor in response to a bias setting applied by said processor and said processor determines the magnetic field component sensed by said sensor as a function of the bias setting applied to said sensor.

19. (Withdrawn) The magnetometer of claim 17, wherein the peak to peak excursion of the magnetic field level in said resonant sensor during a resonant cycle is less than one-half of the field level excursion range due to the adjustment of the bias circuit over its total range of adjustment.

20. (Withdrawn) The magnetometer of claim 17, wherein the peak to peak excursion of the magnetic field level in said resonant sensor during a resonant cycle is less than one-fourth of the field level excursion range due to the adjustment of the bias circuit over its total range of adjustment.

21. (Original) A magnetometer comprising:

a resonant sensor for sensing a magnetic field, said sensor generating an output signal having a signal characteristic that varies in response to the sensed magnetic field; and

a processor coupled to receive the output signal from said sensor, said processor determines the magnetic field component sensed by said sensor,

wherein the peak to peak excursion of the magnetic field level in said resonant sensor during a resonant cycle is less than the total range of the magnetic field to be measured.

22. (Original) The magnetometer of claim 21, wherein the peak to peak excursion of the magnetic field level in said resonant sensor during a resonant cycle is less than one-half of the total range of the magnetic field to be measured.

23. (Withdrawn) The magnetometer of claim 21 and further including a biasing circuit for dynamically biasing said resonant sensor in response to a bias setting applied by said processor and said processor determines the magnetic field component sensed by said sensor as a function of the bias setting applied to said sensor.

24. (Canceled)

25. (New) The magnetometer of claim 23, wherein said processor is operable to generate the bias setting and thereby control said biasing circuit to dynamically bias said sensor such that the signal characteristic of the output signal is maintained within a relatively small target range of levels.

26. (New) The magnetometer of claim 25, wherein said processor determines the magnetic field component sensed by said sensor as a function of both the bias setting applied to said sensor and the level of the output signal in the target range to enhance the resolution of the reading.

27. (New) The magnetometer of claim 23, wherein the peak to peak excursion of the magnetic field level in said resonant sensor during a resonant cycle is less than one-fourth of the field level excursion range due to the adjustment of the bias circuit over its total range of adjustment.

28. (New) The magnetometer of claim 23, wherein said sensor comprises a first sensing element having a sensor characteristic that varies in response to a magnetic field, and a second sensing element having a sensor characteristic that varies in response to a magnetic field,

wherein said biasing circuit adjustably biases said first sensing element to at least a first bias level and a second bias level, and for adjustably biasing said second sensing element to at least a third bias level and a fourth bias level, and

wherein said processor is coupled to said first and second sensing elements to receive the output signals from said sensing elements, said processor measures the magnetic field components sensed by said sensing elements by sequentially:

sampling the output signal of said first sensing element at the first bias level,

sampling the output signal of said second sensing element at the third bias level,

sampling the output signal of said second sensing element at the fourth bias level,

sampling the output signal of said first sensing element at the second bias level,

determining the magnetic field component of said first sensing element as a function of the samples taken at the first and second bias levels, and

determining the magnetic field component of said second sensing element as a function of the samples taken at the third and fourth bias levels.

29. (New) The magnetometer of claim 28 and further comprising a third sensing element having a sensor characteristic that varies in response to a magnetic field, wherein:

said biasing circuit adjustably biases said third sensing element to at least a fifth bias level and a sixth bias level; and

said processor is further coupled to receive the output signal from said third sensing element, said processor measures the magnetic field components sensed by said sensing elements by sequentially:

sampling the output signal of said first sensing element at the first bias level,

sampling the output signal of said second sensing element at the third bias level,

sampling the output signal of said third sensing element at the fifth bias level,

sampling the output signal of said third sensing element at the sixth bias level,

sampling the output signal of said second sensing element at the fourth bias level,

sampling the output signal of said first sensing element at the second bias level,

determining the magnetic field component of said first sensing element as a function of the samples taken at the first and second bias levels,

determining the magnetic field component of said second sensing element as a function of the samples taken at the third and fourth bias levels, and

determining the magnetic field component of said third sensing element as a function of the samples taken at the fifth and sixth bias levels.

30. (New) The magnetometer of claim 23, wherein said sensor comprises a first sensing element having a sensor characteristic that varies in response to a magnetic field, and a second sensing element having a sensor characteristic that varies in response to a magnetic field,

the magnetometer further comprising at least one analog switch provided for selecting said first or second sensing element, said at least one analog switch having a resistance,

wherein said biasing circuit supplies a biasing current to a selected one of said sensing elements, and said processor is coupled to receive output signals from a selected one of said first and second sensing elements and is coupled to said at least one analog switch to select one of said first and second sensing elements,

wherein said biasing circuit is configured to supply a biasing current that is substantially independent of the resistance of said at least one analog switch over a range of operation.

31. (New) The magnetometer of claim 23, wherein said sensor comprises a first sensing element having a sensor characteristic that varies in response to a magnetic field, and a second sensing element having a sensor characteristic that varies in response to a magnetic field,

the magnetometer further comprising at least one analog switch provided for selecting said first or second sensing element,

wherein said biasing circuit adjustably biases said sensing elements to at least a first bias level and a second bias level, said processor is coupled to receive output signals from a selected one of said first and second sensing elements and is coupled to said at least one analog switch to select one of said first and second sensing elements,

wherein said biasing circuit biases one of said sensing elements at the first bias level and subsequently biases the same sensing element at the second bias level without any analog switch changing states.

32. (New) The magnetometer of claim 23, wherein the bias setting selected to determine the magnetic field component is based on the difference in bias current at two points for which the output signal achieves a target response.

33. (New) The magnetometer of claim 23, wherein the bias setting selected to determine the magnetic field component is based on no more than five prior raw readings obtained from said sensor.

34. (New) The magnetometer of claim 23, wherein the bias setting serves to approximately balance the field to be measured in each of two target ranges of sensor response.

35. (New) The magnetometer of claim 23, wherein the bias setting is selected to bring the output signal of said sensor within the target range for one of two different ranges where a targeted response value may be attained.

36. (New) The magnetometer of claim 35, wherein the bias setting is subsequently selected to bring the output signal of said sensor within a second target range corresponding to the other one of the two different ranges where a targeted response value may be attained.

37. (New) The magnetometer of claim 23, wherein said processor measures the output signal response and determines the bias needed to achieve a target response value based upon the present bias setting and the output signal response.

38. (New) The magnetometer of claim 23, wherein said processor determines the magnetic field component sensed by said sensor as a function of two bias settings for which at least one targeted response value may be attained.

39. (New) The magnetometer of claim 23 and further comprising a multiple pole filter coupled to an output of said biasing circuit for filtering the bias to be applied to said sensor.

40. (New) The magnetometer of claim 23, wherein said processor controls said biasing circuit to dynamically bias said sensor such that the signal characteristic of the output signal is maintained in one of two target ranges.

41. (New) The magnetometer of claim 40, wherein said processor determines in which of the two target ranges the signal characteristic of the output signal falls based upon the sign of the slope of the plot of the bias setting versus output signal characteristic.

42. (New) The magnetometer of claim 40, wherein the total range through which said sensor may be biased by said biasing circuit approximately spans the range required for biasing said sensor to have output signal characteristics falling within both of the two target ranges plus the range required for sensing external magnetic field intensities to be measured.

43. (New) The magnetometer of claim 23, wherein said biasing circuit comprises a pulse-width modulated digital-to-analog converter for setting a bias current for said sensor, said digital-to-analog converter having an accuracy that is substantially greater than its incremental resolution.

44. (New) The magnetometer of claim 23, wherein said processor uses the bias setting signal for a measurement from said sensor that is based on a previous reading from said sensor.

45. (New) The magnetometer of claim 23, wherein said processor initiates a search sequence to find the bias setting for which a target response may be determined.

46. (New) The magnetometer of claim 21, wherein the signal characteristic is the phase of the output signal.

47. (New) The magnetometer of claim 21, wherein the signal characteristic is the frequency of the output signal.

48. (New) The magnetometer of claim 21, wherein said sensor has an inductance that varies as a function of the strength of the sensed magnetic field.

49. (New) The magnetometer of claim 21, and further comprising a phase discrimination circuit coupled between said sensor and said processor.

50. (New) The magnetometer of claim 21 and further comprising an excitation circuit coupled to said resonant sensor for supplying an excitation signal thereto.

51. (New) The magnetometer of claim 21, wherein said processor filters measurements from said sensor to reject a cyclically varying magnetic field generated by current flowing through AC power lines.

52. (New) The magnetometer of claim 21, wherein said sensor constitutes a first sensor for sensing a first component of a magnetic field, said magnetometer further comprising:

a second sensor for sensing a second component of the magnetic field, each of said sensors generating an output signal having a frequency that varies in response to the sensed component magnetic field and in response to an applied bias current; and

a biasing circuit for generating bias currents to dynamically bias said first and second sensors, wherein said processor is coupled to receive the output signals from said sensors and coupled to said biasing circuit, said processor operable to control said biasing circuit to dynamically vary said bias currents applied to said sensors such that the frequency of the output signals is maintained within one or more target frequency ranges, said processor determines the magnetic field components sensed by said sensors as a function of the biasing currents applied to said sensors.

53. (New) The magnetometer of claim 21, wherein said sensor generates an output signal having a characteristic that varies substantially linearly in response to the sensed magnetic field components throughout a first range of magnetic field levels, wherein the magnetic field component varies throughout a second range of magnetic field levels, the magnetometer further comprises:

a magnetic field generating mechanism for generating a magnetic field that is summed with any external magnetic field such that the resultant magnetic field is sensed by said sensor, the strength of the generated magnetic field being selectively variable,

wherein said processor is coupled to said magnetic field generating mechanism, said processor operable to control said magnetic field generating mechanism to select the field strength of the generated magnetic field and thereby dynamically shift and/or maintain the second range within the first range.

54. (New) An electronic compass for a vehicle comprising the magnetometer defined in claim 21 and further comprising:

a second sensor for sensing a second component of the magnetic field, the second component being orthogonal to the first component as sensed by the other sensor;

a processing circuit for computing a vehicle heading as a function of the magnetic field components determined by said magnetometer; and

a heading indicator coupled to said processing circuit for indicating the vehicle heading.

55. (New) The magnetometer of claim 21, wherein said sensor comprises a first sensing element having a sensor characteristic that varies in response to a magnetic field, and a second sensing element having a sensor characteristic that varies in response to a magnetic field;

a single first analog switch provided for selecting said first sensing element;

a single second analog switch provided for selecting said second sensing element; and

a processor coupled to receive output signals from a selected one of said first and second sensing elements and coupled to said first and second analog switches to select one of said first and second sensing elements.

56. (New) An electronic compass for a vehicle comprising:

a resonant sensor for sensing a magnetic field, said sensor generating an output signal having a signal characteristic that varies in response to the sensed magnetic field; and a processor coupled to receive the output signal from said sensor, said processor determines the magnetic field component sensed by said sensor; and

a heading indicator coupled to said processor for indicating the vehicle heading,

wherein the peak to peak excursion of the magnetic field level in said resonant sensor during a resonant cycle is less than the total range of the magnetic field to be measured.

57. (New) The electronic compass of claim 56, wherein the peak to peak excursion of the magnetic field level in said resonant sensor during a resonant cycle is less than one-half of the total range of the magnetic field to be measured.

58. (New) The electronic compass of claim 56 and further including a biasing circuit for dynamically biasing said resonant sensor in response to a bias setting applied by said processor and said processor determines the magnetic field component sensed by said sensor as a function of the bias setting applied to said sensor.